Generic Framework for Vehicle Driver Assistance System to Prevent Against Vulnerable Road Traffic Pedestrians

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Abstract: Driver assistance systems required by Daimler *and* Volvo automobiles for their future generation cars are to be designed in order to detect dangerous situations involving pedestrians ahead of time, allowing the control the vehicle. In order to meet those challenges, we propose a Generic Framework. The framework gives the structure and outline for the active researchers aimed at improving traffic safety. The necessary components for monitoring and reaching a safe state and their embedment in a basic, functional Architecture of a driver assistance system are shown in the framework. This paper also provides the various phases for pedestrian tracking and driver assistance systems as a collective framework which can be utilized by people who apply different approaches in their work. The ideas from different work are also collected and this study highlights the optimal approaches provided in those proposals.

Keywords: Driver Assistance Systems, Segmentation, Detection, Pedestrian Classification, Pedestrian Tracking.

1. INTRODUCTION

The first investigations on pedestrian tracking for Pedestrian Protection Systems were presented in the late 1990s. Since then, Pedestrian Tracking has become a hot technological challenge that is of major interest to governments, automotive companies, suppliers, universities, and research centers. As a result, many papers addressing on-board pedestrian detection have been published, a few of which partially survey the state of the art. The main future aim in this research area is visual pedestrian detection and tracking from a moving vehicle. More research is needed before such systems can perform active vehicle control reliably. The contribution of this study is two-fold. First, it presents a general module-based architecture that gives a general outline for pedestrian tracking and driver assistance tasks. Second, it provides a general discussion of the overall systems, pointing out the current limitations and future trends from a more general viewpoint. All the highlights of the related works are listed out in section 2. In section 3, we propose a Generic Framework under which the various modules such as segmentation, pedestrian classification, pedestrian tracking, risk assessment and warning control strategies are discussed from a more general perspective. Section 4 gives the conclusion of this paper which is aimed at helping researchers in the field of pedestrian tracking and driver assistance systems.

2. RELATED WORKS

Markus Enzweiler et al. [1] proposed an overview of the main components of a pedestrian detectionsystem and the underlying models from both methodological and experimental perspectives. Two evaluation settings: a generic setting, where evaluation is done without scene and processing constraints and one

specific to an application onboard a moving vehicle in traffic were considered. The HOG-based linear SVM approach significantly outperformed all other approaches considered at little or no processing constraints. D. M. Gavrila et al. [2] proposed a multi-cue vision system for real-time pedestrian detection and tracking from a moving vehicle. This paper analyzed the performance of individual modules and their interaction by means of Receiver Operator Characteristics and the performance was furthermore enhanced by a restriction of the sensor coverage area and more processing time. Cao Yuzhen et al. [3] proposed a method for extracting pedestrian crossing based on image processing, which contains bipolarity testing, morphological operations, edge detection and Radon Transform techniques. The algorithm was proved to have a high recognition rate in pedestrian crossing detection. David Gerónimo et al. [4] proposed a system that detects pedestrians from a moving vehicle in urban scenarios and searches for aspect changing objects in cluttered environments. It has also proposed a strategy to combine 2D/3D information in a cooperative module scheme where the output results of each step are used as input of next. In this way, 2D and 3D cues are exploited in each step depending on the task to be achieved and taking into account the limitations of the data. Dariu M. Gavrila et al. [5] proposed a novel probabilistic approach to hierarchical, exemplar based shape matching. The approach uses a template tree to efficiently represent and match the variety of shape exemplars. The main contribution of this paper is a Bayesian model to estimate the a posteriori probability of the object class, after a certain match at a node of the tree.

Markus Hörwick et al. [6] explained the difference between fully automatic and autonomous driving assistance systems. It proposes two different strategies to reach a safe state in consequence of a system boundary crossing. The strategies and components of the safety concept presented in this work are crucial for guaranteeing enduring safety in such DAS and in consequence for making automatic driving functions commercially ready for serial production. W. Jianqiang et al. [7] presented a driving simulation platform with low cost for the development of driving assistance systems (DAS).It illustrates that the proposed control algorithms for actuators possess good tracking capability, as well as that the developed ACC algorithm is capable of improving driver comfort and reducing driver workload. The proposed adjustment method for vision rendering software further strengthens driver's immersion feeling on virtual traffic scene, improving its reliability of disclosing driver characteristics. Evdokimos I. Konstantinidis et al. [8] proposed the development and evaluation of a system targeting to vehicle collision avoidance in emergency situations by wireless communication among vehicles. The maximum covering range discussed provides sufficient time to drivers in order to act and avoid a possible collision. This low cost and low power consumption system can be easily installed and integrated to any vehicle, old or new, as it operates independently of the rest vehicle's electronic systems. Ying-Che Kuo et al. [9] proposed a vision-based vehicle detection method for collision warning of driver assistance system on highway in the nighttime. The major function of their work is to find preceding vehicles in the dynamic background by extracting the tail lights of vehicles by using multi-level image processing algorithms and cluster processing and also estimating the related distance between the test car and the preceding vehicle for collision warning. I.P. Alonso et al. [10] proposed a components based learning approach in order to better deal with pedestrian variability, illumination conditions, partial occlusions, and rotations. Extensive comparisons have been carried out using different feature extraction methods as a key to image understanding in real traffic conditions.

A. Broggi et al. [11] proposed the application of a stereoscopic technique as a preprocessing for the localization of humans in generic unstructured environments. Each row of the left image is matched with the epipolar row of the right image. This creates a map of each object in the scene as well as the slope of the road. M. Enzweiler et al. [12] presented a novel approach to pedestrian classification which involves utilizing the synthesized virtual samples of a learned generative model to enhance the classification performance of a discriminative model. Active learning provides the link between the generative and discriminative model, in the sense that the former is selectively sampled such that the training process is guided towards the most informative samples of the latter. L. Petersson et al. [13] discussed about driver assistance systems, lists a set of necessary core competencies of such a system and in particular presents a system for force-feedback in the steering wheel when crossing lanes. The presented system utilizes a robust lane tracker which is experimentally evaluated for the purpose of driver assistance. M. Bertozzi et al. [14] proposed a vision-based system for detecting and localizing pedestrians in road environments by means of

a statistical technique. Initially, attentive vision techniques relying on the search for specific characteristics of pedestrians such as vertical symmetry and strong presence of edges, allow selecting interesting regions likely to contain pedestrians. These regions are then used to estimate the localization of pedestrians using a Kalman filter estimator. M. Bertozzi et al. [15] presented an implementation of a vision-based system for recognizing pedestrians in different environments and precisely localizing them with the use of a Kalman filter estimator configured as a tracker. The information produced is then passed on to the tracker module which reconstructs an interpretation of the pedestrian positions in the scene.

3. GENERIC FRAMEWORK

The generic framework presents a general module based architecture that gives a general outline for pedestrian detection and driver assistance tasks in fig 1. Generic Framework includes the various modules such as segmentation, Detection, pedestrian classification, pedestrian tracking, risk assessment and warning control strategies. The images captured by the sensors are preprocessed and then segmented. Then the pedestrians are detected based on their edges and shapes through various techniques. The pedestrians are classified based on the example training datasets and the speed and direction of the mobile pedestrians are tracked. The warning control strategies are assessed and necessary control actions are provided to the automobile brake control system.

3.1 Segmentation

Segmentation is a process which is used to simplify or change the representation of an image into something that is more meaningful and easier to analyze by assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. Various techniques can be used by researchers such as threshold techniques, edge-based methods, region-based techniques, and connectivity preserving relaxation methods.

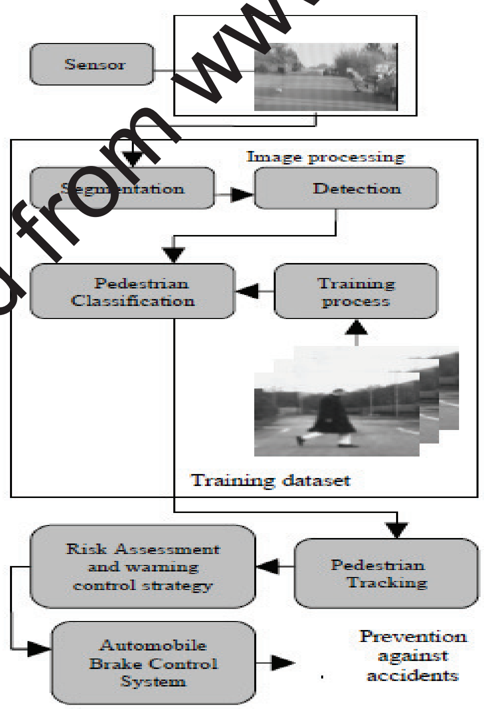

Fig 1: Generic Framework for Pedestrian tracking and driver assistance system.

Clustering methods

The K-means algorithm is an iterative technique that is used to partition an image into K clusters.

Compression-based methods

Compression based methods postulate that the optimal segmentation is the one that minimizes, over all possible segmentations, the coding length of the data.

Histogram-based methods

Histogram-based methods are very efficient when compared to other image segmentation methods because they typically require only one pass through the pixels. In this technique, a histogram is computed from all of the pixels in the image, and the peaks and valleys in the histogram are used to locate the clusters in the image.

Edge detection

Edge detection is a well-developed field on its own within image processing. Region boundaries and edges are closely related, since there is often a sharp adjustment in intensity at the region boundaries.

Partial Differential Equation methods

One suitable method for image segmentation is to use a Partial Differential Equation (PDE) and solve it by a numerical scheme to get the image segmented.

Graph partitioning methods

Graph partitioning methods can effectively be used for image segmentation. In these methods, the image is modeled as a weighted, undirected graph. Usually a pixel or a group of pixels are associated with nodes and edge weights define the dissimilarity between the neighborhood pixels. The graph image is then partitioned according to a criterion designed to model "good" clusters. Each partition of the nodes (pixels) output from these algorithms are considered an object segment in the image.

Watershed transformation

The watershed transformation considers the gradient magnitude of an image as a topographic surface. Pixels having the highest gradient magnitude intensities (GMIs) correspond to watershed lines, which represent the region boundaries. Water placed on any pixel enclosed by a common watershed line flows downhill to a common local intensity minimum (LIM). Pixels draining to a common minimum form a catch basin, which represents a segment.

Multi-scale segmentation

Image segmentations are computed at multiple scales in scale-space and sometimes propagated from coarse to fine scales. More recently, these ideas for multiscale image segmentation by linking image structures over scales have been picked up. Structures detected in scale-space above a minimum noise threshold are associated in an object tree which spans multiple scales and corresponds to a kind of feature in the original signal. Extracted features are accurately reconstructed using an iterative conjugate gradient matrix method.

3.2. Detection

Module for human shape filtering can be developed to detect the pedestrians based on their edge, shape and movement orientation features. The Pedestrian Detection functionality is aimed at sensing and localizing the objects with a human shape. Pedestrians are detected through a search for objects featured by specific characteristics, using a single monocular image sequence. Shape Analysis and classification provides a rich resource for the computational characterization and classification of general shapes, from characters to biological entities. The shape of each segment is described both by its significant boundary sections and by regional, dense orientation information derived from the segment's shape. Shapebased techniques allow the recognition of both moving and stationary pedestrians. Edge detection is a fundamental tool in image processing and computer vision, particularly in the areas of feature detection and feature extraction, which aim at identifying points in a digital image at which the image brightness changes sharply or more formally has discontinuities. Numerous approaches have been proposed.

Holistic Detection

Detectors are trained to search for pedestrians in the video frame by scanning the whole frame. The detector would "fire" if the image features inside the local search window meet certain criteria. Some methods employ global features such as edge template, others uses local features like Histogram of oriented gradients descriptors. The drawback of this approach is that, the performance can be easily affected by background clutter and occlusions.

Part-based Detection

Pedestrians are modeled as collections of parts. Part hypotheses are firstly generated by learning local features, which includes edge let features, the orientation features, and etc. These part hypotheses are then joined to form the best assembly of existing pedestrian hypotheses. Though this approach is attractive, part detection itself is a difficult task.

Patch-based Detection

A codebook of local appearance is learned during the training process. In the detecting process, extracted local features are used to match against the codebook entries, and each match casts one vote for the pedestrian hypotheses. Final detection results can be obtained by further refining those hypotheses. The advantage of this approach is only a small number of training images are required.

3.3 Pedestrian Classification

The acquired images are classified into pedestrians and non-pedestrians based on the available images in the training data set by shape-based pedestrian detector that matches a given set of pedestrian shape templates to the images. Pedestrian images were obtained from manually labeling and extracting the rectangular positions of pedestrians in video images. Video images were recorded at various times and locations with no particular constraints on pedestrian pose or clothing, except that pedestrians are standing in upright position and are fully visible. As non-pedestrian images, patterns representative for typical preprocessing steps within a pedestrian classification application, from video images known not to contain any pedestrians. We can use a shape-based pedestrian detector that matches a given set of pedestrian shape templates to distance transformed edge images. The ability to automatically detect pedestrians in images is a key for a number of application domains such as surveillance and intelligent vehicles. Large variations in pedestrian appearance (e.g. clothing, pose) and environmental conditions (e.g. lighting, background) make this problem particularly challenging. A typical approach starts by identifying regions of interest in the image using a computationally efficient method (e.g. background subtraction, motion detection, obstacle detection) and thereafter moves on to a more expensive pattern classification step.

3.4 Pedestrian Tracking

Once the image is been classified into pedestrians and non-pedestrians, the next step is to keep track with direction and speed of the pedestrians who are in mobile state. The tracking component aggregates perframe detections to trajectories by a tracking module. The tracking is performed in the high-dimensional space of shape model parameters which consists of Euclidean transformation parameters and deformation parameters. Some methods are Pedestrian Tracking Based on Colors and Spatial Information, Modified particle filter-based infrared pedestrian tracking, pedestrian tracking using discrete choice models and image correlation techniques. In human tracking, the tracking algorithms can be categorized into four groups: region-based, contour-based, feature-based and model-based. The first three groups suffer from a common disadvantage in handling occlusions, while the model-based tracking algorithms are very consuming and could not be used in real time. Since most of the solutions proposed by these methodologies are computationally expensive, Kalman filtering is still the most commonly used algorithm for tracking.

3.5 Risk Assessment and Control Strategy

Finally, the risk assessment and warning/control component evaluates the probability of collision; if the latter exceeds a threshold an acoustic driver warning is given or automatic vehicle braking is applied by the automobile brake control system to either avoid the accident entirely or to at least minimize the severity of the hit.

4. CONCLUSION

Beside the adherence of basic principles and methods for functional safety, the strategies and components of the safety concept presented in this work are crucial for guaranteeing safety in vehicle driver assistance systems. The conventional meaning of the word "safety concept" aims at assuring and guaranteeing, that a certain product fulfills certain tasks faultlessly. To achieve this, our paper provides various phases for tracking the pedestrians and driver assistance systems as a generic framework which can be utilized by people who apply different approaches in their work. Altogether we are optimistic about future achievements in this field of research.

REFERENCES

[1] Markus Enzweiler, Dariu M.Gavrila. "Monocular Pedestrian Detection: Survey and Experiments". IEEE Transactions on pattern analysis and machine intelligence, vol. 31, no. 12, Dec 2009.

[2] D. M. Gavrila, S. Munder. "Multi-cue Pedestrian Detection and Tracking from a Moving Vehicle", International Journal of Computer Vision 73(1), 41–59, 2007

[3] Cao Yuzhen, Chen Lushi, Jia Shuo. "An Image Based Detection of Pedestrian Crossing". IEEE 2009.

[4] David Gerónimo *, Angel D. Sappa, Daniel Ponsa, Antonio M. López. "2D–3D-based on-board pedestrian detection system", IEEE 2010.

[5] Dariu M. Gavrila. "A Bayesian, Exemplar-Based Approach to Hierarchical Shape Matching", IEEE Trans. Pattern analysis and machine intelligence, vol. 29, no. 8, August 2007.

[6] Markus Hörwick and Karl-Heinz Siedersberger. "Strategy and Architecture of a Safety Concept for Fully Automatic and Autonomous Driving Assistance Systems". IEEE june2010 Intelligent Vehicles Symposium

[7] W. Jianqiang L. Shengbo H. Xiaoyu L. Keqiangdec. "Driving simulation platform applied to develop driving assistance systems". IEEE 2009

[8] Evdokimos I. Konstantinidis, George I. Patoulidis, Ioannis N. Vandikas, Constantinos Parisses, Nikos Asimopoulos. “Development of a Collaborative Vehicle Collision Avoidance System”. IEEE jun2010

[9] Ying-Che Kuo, Hsuan-Wen Chen. “Vision-based Vehicle Detection in the Nighttime”. IEEE 2010

[10] I.P. Alonso et al. “Combination of Feature Extraction Methods for SVM Pedestrian Detection,” IEEE Trans. Intelligent Transportation Systems, vol. 8, no. 2, pp. 292-307, June 2007.

[11] A. Broggi, A. Fascioli, I. Fedriga, A. Tibaldi, and M.D. Rose, “Stereo-Based Preprocessing for Human Shape Localization in Unstructured Environments” , Proc. IEEE Intelligent Vehicles Symp., pp. 410-415, 2003.

[12] M. Enzweiler and D.M. Gavrila, “A Mixed Generative- Discriminative Framework for ◆Pedestrian Classification”, Proc. IEEE Int’l Conf. Computer Vision and Pattern Recognition, 2008.

[13] Petersson, L. Apostoloff, N. Zelinsky, A. “Driver assistance: an integration of vehicle monitoring and control”, Robotics and Automation, 2003. Proc. ICRA '03. IEEE International Conference. Sept. 2003 vol.2, pp.2097 - 2103

[14] M. Bertozzi, A. Broggi, R. Chapuis, F. Chausse, A. Fascioli, and A. Tibaldi, “Shape-Based Pedestrian Detection and Localization,” Proc. IEEE Int’l Conf. Intelligent Transportation Systems, pp. 328-333, 2003.

[15] M. Bertozzi, A. Broggi, A. Fascioli, A. Tibaldi, R. Chapuis, and F. Chausse, “Pedestrian Localization and Tracking System with Kalman Filtering,” Proc. IEEE Intelligent Vehicles Symp., pp. 584- 589, 2004.